- Executive Summary
- Company Selection for Benchmark
- **Quality Assurance Framework**
- Benchmark Company Observations
- Industry Quality Assurance Cost Estimates
- Industry Selection of Quality Assurance Methods

We built a framework to categorize and illustrate the quality assurance activities observed during the industry site visits.

Purpose of Framework

- Standardize terminology
- Organize discussion and supporting quality assurance method
- Exemplify how the quality assurance methods work together

Quality Assurance Categories

Category Observations

- Not commodity specific
- Categories are not distinct, they overlap
- Interdependent
- Multiple categories are used concurrently throughout the acquisition timeline

The benchmark companies typically apply several methods within a category and among categories.

— Quality Assurance Categories & Supporting Methods —

Conformity to Design

- Incoming inspection
- Non-delegated source inspection
- Delegated source inspection
- Material qualification
- Acceptance of federal production & type certificates
- Metrology development

Supplier Selection

- Supplier qualification
- Final selection and application of selection criteria
- Supplier certification and ship to stock

Supplier Management

- Recognition of good and bad performance
- Rationalization of supplier base
- Ongoing supplier qualification
- Feedback to suppliers
- Supplier development

Material Sourcing for Quality and Design

- Root cause analysis and resolution
- Part rationalization
- Early supplier involvement
- Joint product development

Failure Management

- On-site technical supplier support
- Return of defective parts under warranty
- Failure tracking

This section will describe each quality assurance category and provide detailed information on each supporting quality assurance method.

Framework

Each Category

Quality Assurance Objectives		
Basic	Progressive	World Class

Each Method

Practices		
Basic	Progressive	World Class

Benchmark Examples

Acquisition Timeline

Origin of Need	Design Specifications Development	Supplier Selection	Start Production	In-Process	End Production	Shipment/ Delivery	Final Use

Prevent ← QA Continuum → Identify

Cost Drivers of Implementation

Cost Drivers of Ongoing Application

Presentation Tools will be introduced as we go through the Quality Assurance categories, and supporting methods.

The world class continuum is a valuable benchmark tool designed to illustrate the progression of practices from the most basic level to world class.

— Quality Assurance Objective for Each Category — *Presentation Tool*

Basic Objectives	Progressive Objectives	World Class Objectives
■ Quality assurance objectives are not aligned to long term strategy and competitive advantage. Does not leverage opportunities for improvement. – Expect supplier defects	■ Quality assurance objectives focus on direct cost reduction. Provides limited incentives for supplier performance improvement.	■ Quality assurance objectives are aligned to long term strategy and seek to minimize total product cost. Pro-actively identifies and leverages opportunities for supplier performance improvement. – Expect high supplier performance

'World class' companies will not necessarily fall into the world class segment in every category.

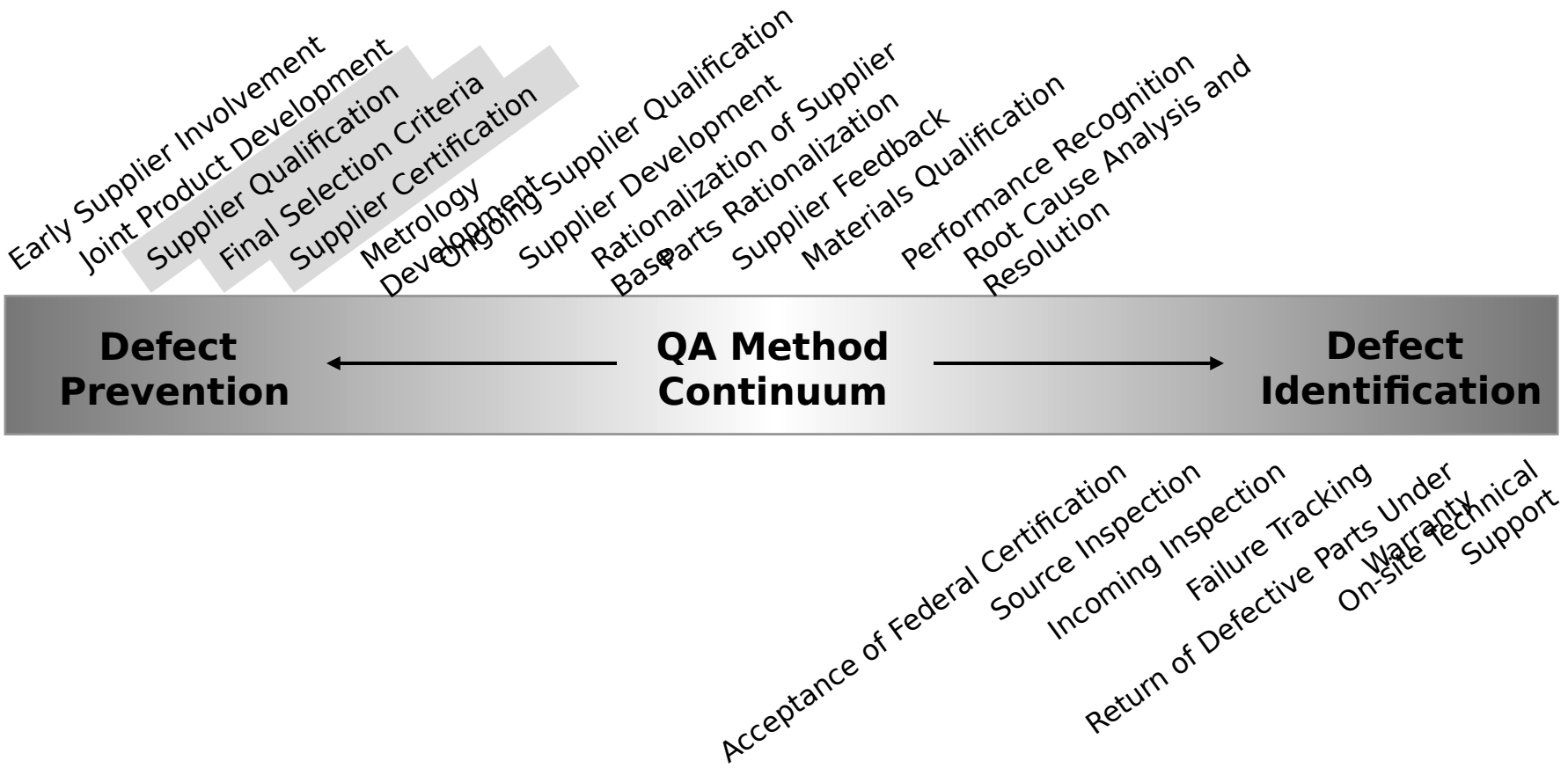
Supplier selection plays a critical role in determining quality assurance requirements throughout the acquisition timeline

— *Supplier Selection* —

Basic Objectives	Progressive Objectives	World Class Objectives
To select lowest bid, minimize direct product cost.	To minimize total product cost, including cost of nonconformance, cost of failure, cost of rework and supplier scrap rate.	To minimize total product cost, and position material sourcing to support long term strategy and competitive advantage.

Acquisition Timeline	■ Occurs after design specifications development, and may occur before the origin of need if the product was jointly developed with a supplier, or if the product was newly developed by a sole supplier
Supporting Methods	■ Supplier qualification • Quality system audit conducted directly by the buyer • Quality system audit conducted by a third party provider on behalf of the buyer • Acceptance of commercial quality standard certification • Acceptance of industry group quality standard compliance • Business health audit • Technical audit ■ Final selection and application of selection criteria • Cross-functional selection teams • Formal supplier selection rating criteria and worksheet ■ Supplier certification which results in suppliers shipping directly to stock

Supplier selection methods plotted along the defect prevention - defect identification continuum.



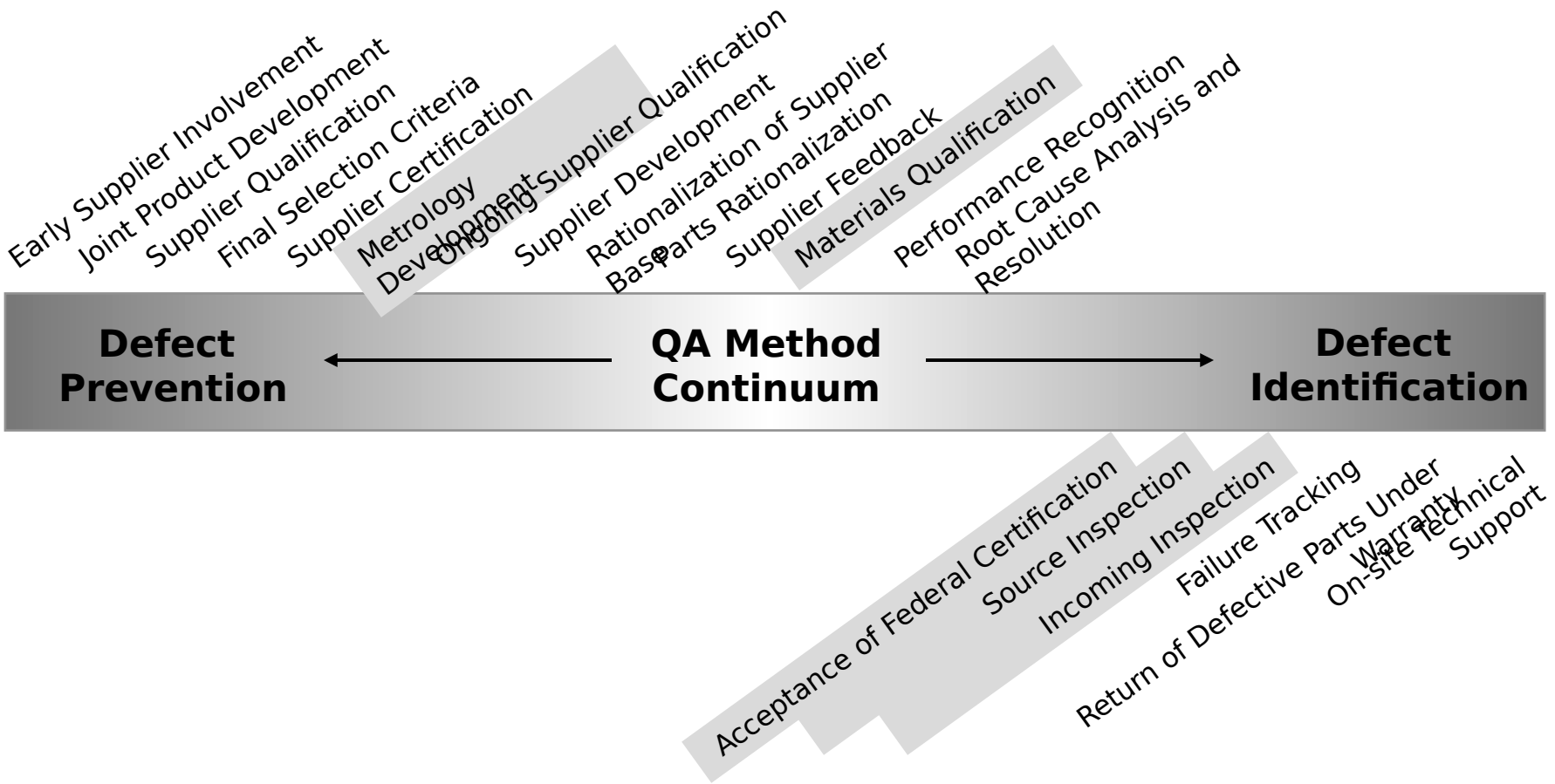
World class conformity to design methods focus more on the integrity of the performance specification itself, than on pure conformity to design.

— Conformity to Design —

Basic Objectives	Progressive Objectives	World Class Objectives
To 'inspect product quality in' in order to seek recourse from supplier; high expectation supplier will produce defects.	To shift responsibility of product quality to supplier in order to provide performance incentives; limited expectation supplier will produce defects.	To prevent production of defects by verifying specification and supplier process control; very limited expectations supplier will produce defects.

Acquisition Timeline	■ Occurs during production and upon acceptance, and may also occur before production begins
Supporting Methods	■ Incoming inspection ■ Non-delegated source inspection and acceptance ■ Delegated source inspection and acceptance ■ Material qualification ■ Acceptance of federal production and type certificates ■ Metrology development

Conformity to Design methods plotted along the defect prevention - defect identification continuum.



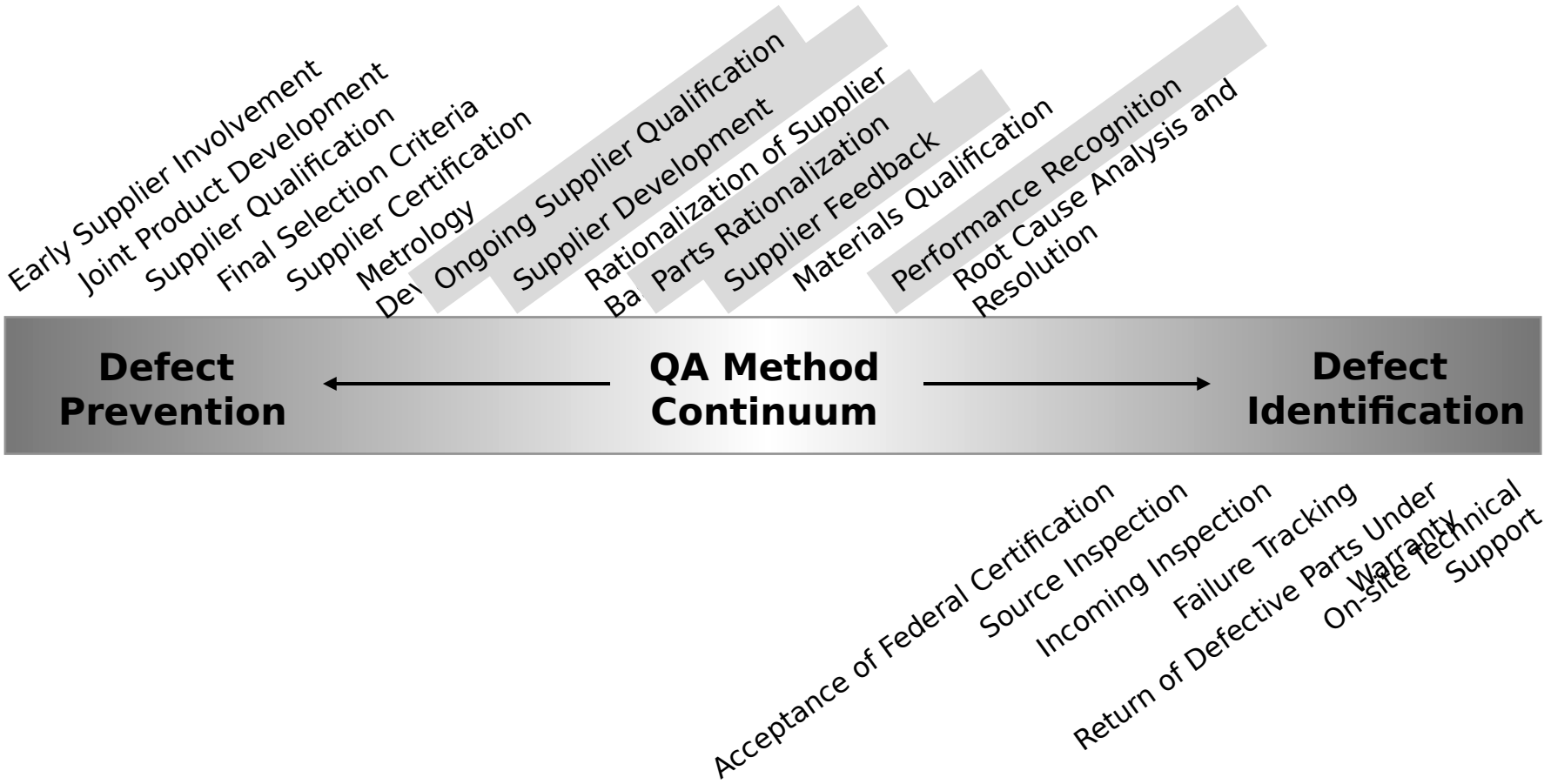
Supplier management encompasses activities used by the buyer to monitor, communicate or improve supplier performance.

— Supplier Management —

Basic Objectives	Progressive Objectives	World Class Objectives
To maintain static supplier performance level to minimum acceptable criteria.	To prevent recurrence of product defects or failures.	To improve supplier performance by pro-actively engaging the supplier in process quality improvement projects. To foster partnership with supplier.

Acquisition Timeline	■ Occurs throughout the acquisition timeline
Supporting Methods	■ Recognition of good and bad performance ■ Ongoing supplier qualification ■ Rationalization of supplier base ■ Feedback to suppliers ■ Supplier development

Supplier Management methods plotted along the defect prevention - defect identification continuum.



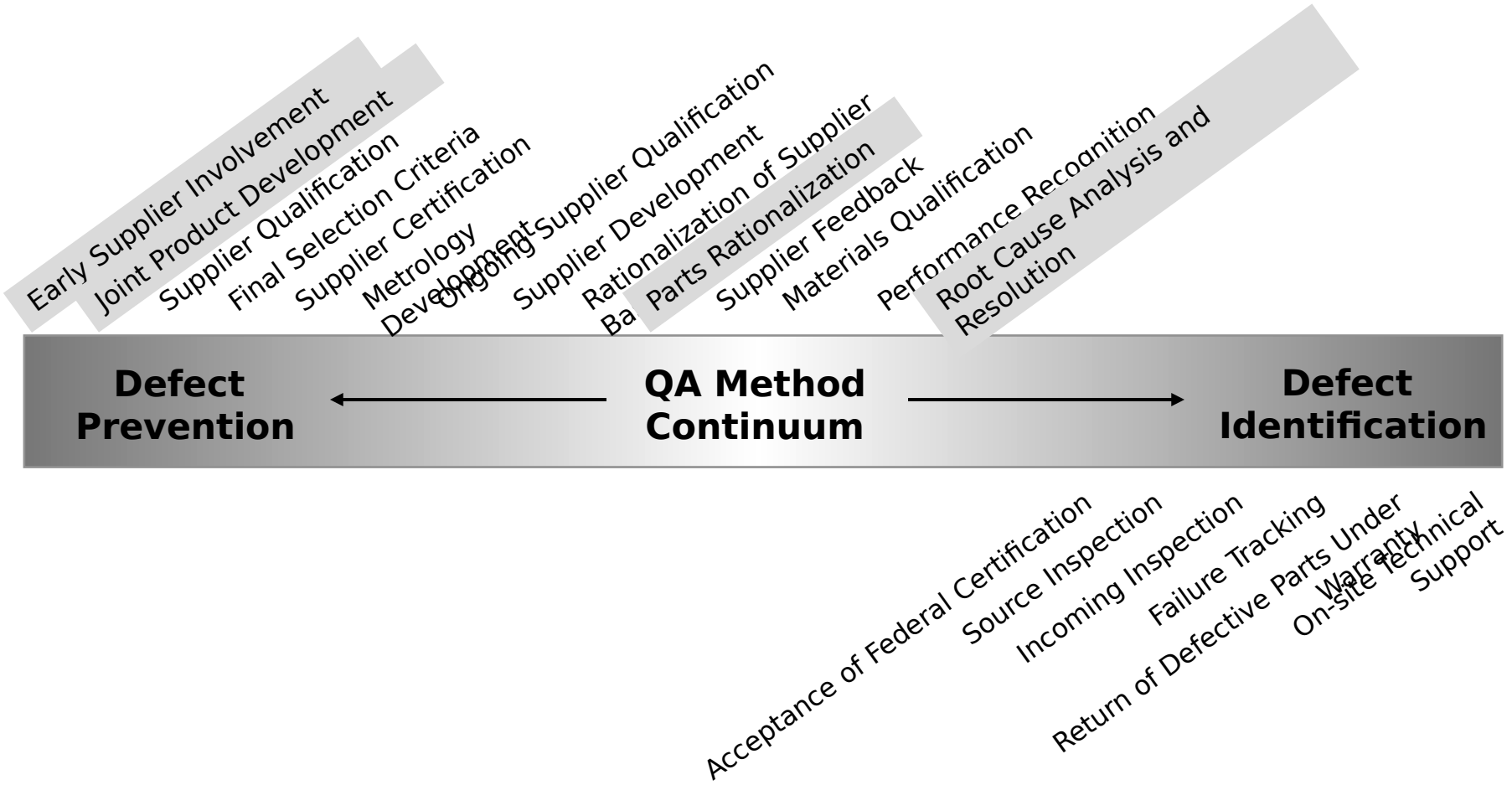
"Building quality in" captures the nature of the quality assurance methods in this category.

— Material Sourcing for Quality and Design —

Basic Objectives	Progressive Objectives	World Class Objectives
To procure to design specifications. Limited management of parts re-work.	To procure to performance specifications from a base of previously qualified part numbers or suppliers. Active management to reduce parts re-work.	To position material sourcing and supplier relationships to support long term strategy and competitive advantage by continuously improving product performance.

Acquisition Timeline	■ Occurs throughout the origin of need and production periods on the acquisition timeline.
Supporting Methods	■ Root cause analysis and resolution ■ Part rationalization ■ Early supplier involvement ■ Joint product development

Materials Sourcing for Quality and Design methods plotted along the defect prevention - defect identification continuum.



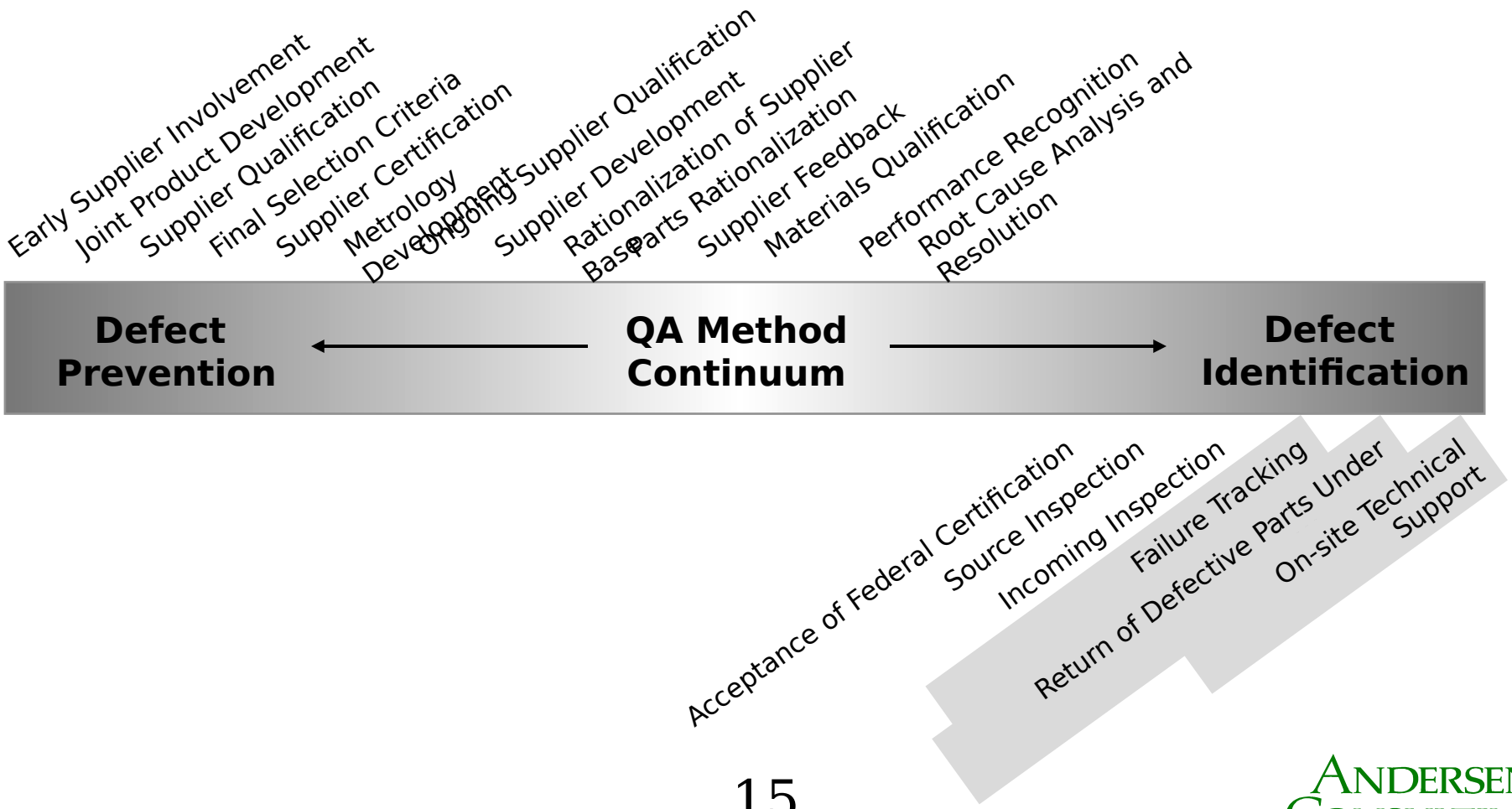
Sophisticated applications of failure management require the exchange of product performance data, and enable the supplier and buyer to improve production process or product design.

— Failure Management —

Basic Objectives	Progressive Objectives	World Class Objectives
To identify failures and seek recourse from supplier.	To identify failures and motivate suppliers to prevent recurring defects.	To identify and investigate failures, and motivate supplier to improve performance.

Acquisition Timeline	■ Occurs at the end of the acquisition timeline
Supporting Methods	■ On-site technical supplier support ■ Return of defective parts under warranty ■ Failure tracking

Failure Management methods plotted along the defect prevention - defect identification continuum..



The following slides describe the presentation tools used to illustrate the quality assurance methods.

Framework

Each Category

Quality Assurance Objectives		
Basic	Progressive	World Class

Acquisition Timeline

Origin of Need	Design Specification Development	Supplier Selection	Start Production	In-Process	End Production	Shipment/ Delivery	Final Use

Each Method

Practices		
Basic	Progressive	World Class

- *Benchmark Examples*

Prevent ← QA Continuum → Identify

- *Cost Drivers of Implementation*
- *Cost Drivers of Ongoing Application*

A world class continuum is also shown for each quality assurance method to illustrate the application tasks performed to support basic through world class category objectives.

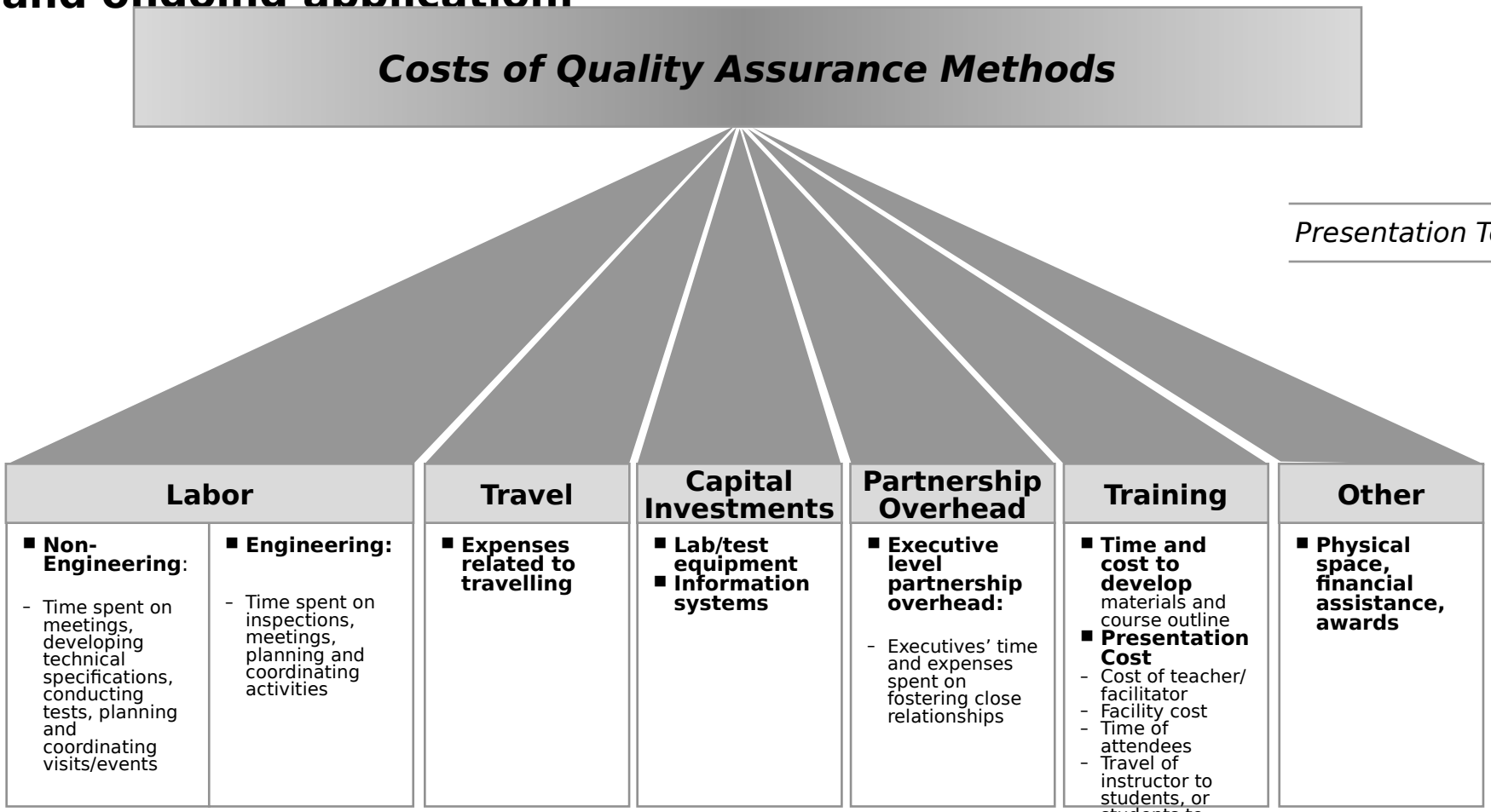
— Practices to Apply Method —

Presentation Tool

Basic Practices	Progressive Practices	World Class Practices
■ Support basic quality assurance objectives *Quality assurance objectives are not aligned to long term strategy and competitive advantage. Does not leverage opportunities for improvement.*	■ Support progressive quality assurance objectives *Quality assurance objectives focus on direct cost reduction. Provides limited incentives for supplier performance improvement.*	■ Support world class quality assurance objectives *Quality assurance objectives are aligned to long term strategy and seek to minimize total product cost. Pro-actively identifies and leverages opportunities for supplier performance improvement.*

The selected examples represent the most sophisticated applications observed during the study.

For each quality assurance method, key resource requirements were identified and segmented into "cost drivers". Subsequent slides explain the cost drivers of implementation and ongoing application.



The acquisition timeline illustrates the sequence of acquisition activities relative to one another, from origin of need to receipt by end user. This presentation tool will appear multiple times in the presentation.

Presentation Tool

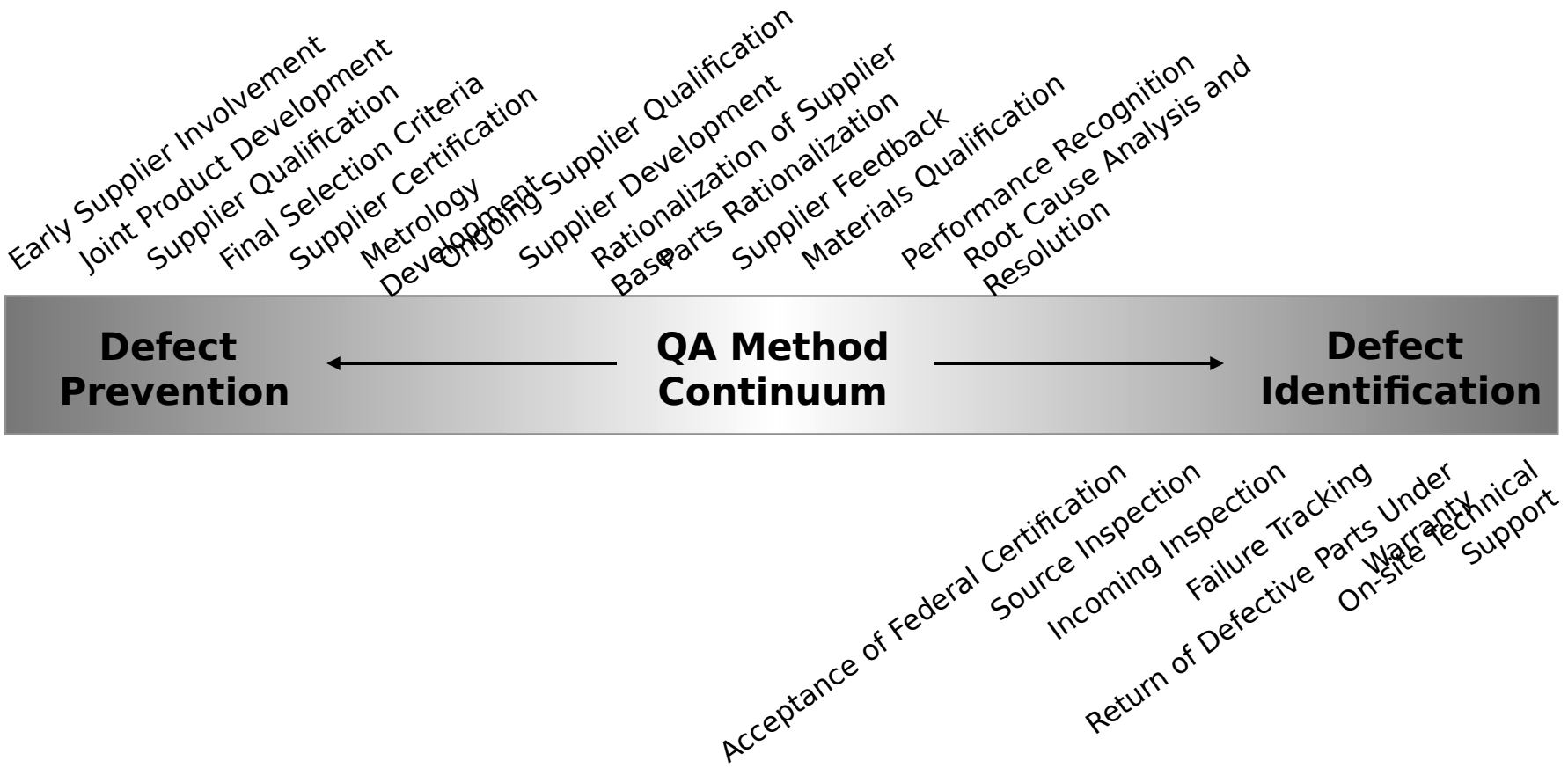
Acquisition Timeline

Origin of Need	Design Specifications Development	Supplier Selection	Start Production	In-Process	End Production	Shipment/ Delivery	Final Use

The quality assurance categories work together and concurrently throughout the acquisition timeline.

The Quality Assurance Method Continuum illustrates which quality assurance methods focus on defect prevention, and which are more focused on identification of defects.

Presentation Tool



— Quality Assurance Method Detail —

Supplier Selection

- Supplier qualification
- Final selection and application of selection criteria
- Supplier certification and ship to stock

In order to reduce the number of potential suppliers to select from, many companies develop qualification criteria for selection eligibility or for inclusion in a qualified supplier list (QSL).

— Supplier Qualification —

Basic Practices	Progressive Practices	World Class Practices
■ Require formal certification or self-certification to ISO9000 as eligibility for selection; or audit supplier to ISO9000 or Malcolm Baldrige standard.	■ Develop customized quality system standard. ■ Perform quality system audit to that standard for selection eligibility. ■ Do not accept certification to ISO9000 or conformance to industry standard. ■ Perform technical and business health audits.	■ Collaborate within industry to develop quality system standard in order to reduce redundant supplier audits. ■ Accept conformance to standard as eligibility for selection. ■ Perform technical and business health audits.

- **Boeing** developed a customized ISO based quality system standard, D1-9000.
- **SEMATECH** developed a quality system standard specific to the semiconductor industry. SEMATECH members use SSQA, a software tool, and share the responsibility of performing and documenting quality system audits.
- The **Coordinating Agency for Supplier Evaluations** (C.A.S.E.) developed a quality system standard specific to aircraft repair vendors. C.A.S.E. members share the responsibility of performing and documenting quality system audits.

Once the qualification standard or criteria is developed, the cost is driven by the frequency and size of a supplier's operations.

— Supplier Qualification —

Cost Drivers of Implementation

- Engineering Labor
  - *Time and expertise of quality or manufacturing engineers to develop quality standard or technical audit criteria.*
  - *Time to coordinate approval by all business units*
  - *Time for business unit engineers to review, respond and attend coordination meetings*
- Travel Expense
  - *Travel to business units coordinating approval*
- Training
  - *Time and expertise to develop training materials and program*
  - *Course presentation cost*

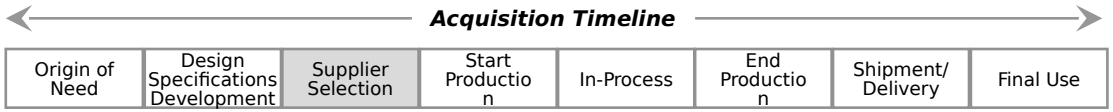
Cost Drivers of Ongoing Application

- Engineering Labor & Non-engineering Labor
  - *Time to coordinate and prepare for qualification audit.*
  - *Time and engineering expertise to conduct.*
  - *Time and quality system expertise to conduct quality audit.*
  - *Time and financial expertise to conduct business audit.*
- Travel Expense
  - *Travel to and from site of supplier.*
- Training
  - *Ongoing development training*
  - *Course presentation cost*

Supplier qualification enables the buyer to allocate more resources to final selection.

— Supplier Qualification —

Point of Application and Impact on Cycle Time



- Occurs during the supplier selection period on the acquisition timeline.
- Does not impact the delivery cycle time of the product, because it occurs before production begins.
- Minimal to zero impact on order placement cycle time, typically occurring before the origin of need.

Benefits

- Enables buyer to spend more resources on supplier selection because it limits the number of suppliers eligible for selection.
- World class applications focus buyers attention for future selection decisions on the most qualified suppliers with the highest probability of meeting quality requirements.

Other

- Use concurrently with final selection to narrow the field of potential suppliers
- Often the first step toward supplier certification
- After suppliers are qualified, an ongoing qualification program should be implemented

During the industry visits we looked at the quality standards used by benchmark companies, finding only one situation where ISO certification was a prerequisite for doing business.

Company	Accept ISO to indicate quality system is in	Standards Other Than ISO	Why & How Specified Standards are Used
Alaska Airlines	No	FAA Certification Required	Responsibility for quality and safety of spares and equipment is on the aircraft manufacturers, who are required to have FAA certification.
Northwest Airlines	No	FAA Certification Required	Aircraft repair stations must first have FAA certification. CASE Repair Station Standards are used in addition to certification.
Boeing Commercial Airplane Group	No	D1 9000 Only	Only use D1 9000 standard to assess suppliers. D1 9000 goes beyond AS 9000 by including specific quality improvement systems and methods, as well as detailed tooling requirements
GE Aircraft Engine Division	No	AS 9000 Only	AS 9000, selection and audit criteria. Although ISO 9000 was used as the foundation for AS 9000, ISO does not cover all FAA requirements.
Intel Corporation - Silicon Materials and Technology Group	Yes Required	Tailored Criteria	The silicon commodity group requires ISO certification of suppliers as a prerequisite for doing business. Additional criteria are used for supplier selection and evaluation.

In all cases, we observed conformance to a quality system standard is used as one of multiple screening tools in the selection of suitable suppliers.

Company	Accept ISO to indicate quality system is in place?	Standards Other Than ISO used?	Why & How Specified Standards are Used
Texas Instruments - Direct Materials Group	Yes	Accent Multiple	Accept certification to a variety of commercial standards in place of a site visit to assess supplier quality systems - SEMATECH SSQA, ISO, Baldrige, etc. This determination is made after a preliminary
Texas Instruments - Equipment Group	No	SSQA Audit	Use the SEMATECH SSQA audit tool, which is based upon ISO and facilitates continuous improvement. This group does not believe ISO focuses enough on quality improvement.
Raytheon - TI Systems	Yes		Suppliers with ISO 9000 certification do not require periodic audits.
Ryder Transportation Services - New Vehicle Purchasing and Quality	No	RFP Criteria	Recent selection of consolidated supplier base represents Ryder certification. May use QS 9000 in the future.
Toyota Automotive Corporation	No	Toyota Specific	Conducts Toyota specific audits which are part of the Toyota Production System.
Hartwell Fastener Corporation	Yes	Accent Multiple	Requires a certified quality system, but does not limit certification to ISO. Accepts other military and commercial quality system certification, such as D1 9000.

World class companies use selection criteria to reduce total cost to the organization, rather than just product unit cost within the acquisition budget.

— Final Selection and Application of Selection Criteria —

Basic Practices	Progressive Practices	World Class Practices
■ Criteria based on price. ■ Potential suppliers are not qualified for eligibility. ■ Final selection performed by acquisition group without consultation with engineering, quality, finance or design.	■ Criteria based on price and delivery. ■ Potential suppliers are qualified for eligibility. ■ Final selection performed by acquisition with the consultation of quality.	■ Criteria based on total product cost, including nonconformance, failure and delivery lead time. May include development of criteria application tools or documentation format. ■ Potential suppliers are qualified for eligibility. ■ Final selection performed by cross-functional team representing acquisition, engineering, quality, finance, marketing and design. ■ Price is analyzed against supplier business health to verify cost viability and profit extraction.

- **Ryder Transportation Services** formed a cross-functional team to perform supplier selection and used a selection worksheet.
- **Toyota Motor Company** encompasses new supplier selection within its 16 step factory ramp up program, which involves every Toyota function and includes extensive materials qualification and capability verification testing.

Once the selection criteria is developed, the cost of final selection is driven by the frequency and number of eligible suppliers.

— Final Selection and Application of Selection Criteria —

Cost Drivers of Implementation

- Engineering Implementation Labor
  - *Time and expertise of quality or manufacturing engineers to develop selection and rating criteria.*
- Information System Infrastructure
  - *Database or spreadsheet applications to support criteria development and supplier rating.*

Cost Drivers of Ongoing Application

- Non-Engineering Application Labor
  - *Time of non-engineering function representatives to participate in selection decision (i.e. cross-functional teams with marketing, finance, purchasing).*
  - *Time to compile supplier data specific to criteria.*
- Engineering Application Labor
  - *Time of engineering function representatives to participate in selection decision.*
- Information System Infrastructure
  - *Database or spreadsheet applications to support compilation of supplier data specific to criteria.*

The use of standardized selection criteria reduces acquisition overhead and the "hidden" costs of supplier selection

— *Final Selection and Application of Selection Criteria* —

Point of Application and Impact on Cycle Time	*Acquisition Timeline*: Origin of Need; Design Specifications Development; **Supplier Selection**; Start Production; In-Process; End Production; Shipment/ Delivery; Final Use ■ Occurs during the supplier selection period of the acquisition timeline. ■ Does not impact the delivery cycle time of the product, because it occurs before production begins. ■ Will become part of the lead time before an order can be placed. World class companies anticipate and plan for this lead time.
Benefits	**Prevent** ← → **Identify** ■ World class applications will support buyer's ability to select the most qualified suppliers with the highest probability of meeting user requirements. ■ Use of cross-functional teams and standardized criteria provides the basis for objective and comprehensive decision making. ■ Use of standardized criteria results in reduced overhead and selection costs.
Other	■ Supplier qualification identifies high potential suppliers and provides both a "better" selection base, and opportunity for a more intensive/comprehensive selection process.

World class applications of supplier certification require extensive materials qualification to determine reliability and capability thresholds.

— Supplier Certification for Ship to Stock —

Basic Practices	Progressive Practices	World Class Practices
■ No supplier certification in place. ■ Delegated source inspection programs may result in ship to stock.	■ Certification program limited to non-critical part numbers. ■ Certification criteria includes specified time period of zero defect production. ■ Certification program not dependent on delegated source inspection.	■ Certification program not limited to non-critical part numbers. ■ Actively works with suppliers to increase the number of parts covered by supplier certification program. Will engage in supplier development activities to support this goal. ■ Certification criteria includes extensive materials qualification, including reliability and capability testing.

- **Toyota Motor Company's** 16 step factory ramp up process includes the certification of all suppliers to ship all part numbers, critical and non-critical, directly to stock.
- **Texas Instruments** certifies non-critical direct material part numbers for ship to stock.
- **Intel Corporation** certifies all strategic and critical silicon suppliers to ship all part numbers directly to stock. The certification process includes extensive materials qualification and capability verification testing.

The cost of supplier certification is driven by frequency of application and intensity of materials qualification activities.

— Supplier Certification for Ship to Stock —

Cost Drivers of Implementation

- Engineering Labor
  - *Time and expertise of design or manufacturing engineers to develop materials qualification and certification criteria.*
  - *Quality engineering expertise and time to determine parts or suppliers eligible for certification.*
- Lab and Test Equipment
  - *Equipment to support development of criteria.*
- Information System Infrastructure
  - *Database and data analysis to support development of criteria.*
  - *Database established to track supplier/part certification ratings and status.*
- Executive Level Partnership Overhead
  - *Requires close coordination with and cooperation of supplier.*
  - *Suppliers must be made aware of the program and potential benefits*

Cost Drivers of Ongoing Application

- Engineering Labor
  - *Time and expertise of design or manufacturing engineers to conduct materials qualification for certification.*
- Lab and Test Equipment
  - *Equipment to support materials qualification.*
- Information System Infrastructure
  - *Database and data analysis to support materials qualification and record certification status/results.*
- Executive Level Partnership Overhead
  - *Requires close coordination with and cooperation of supplier.*

Supplier certification illustrates how world class companies allocate resources to defect prevention in order to reduce total acquisition cost.

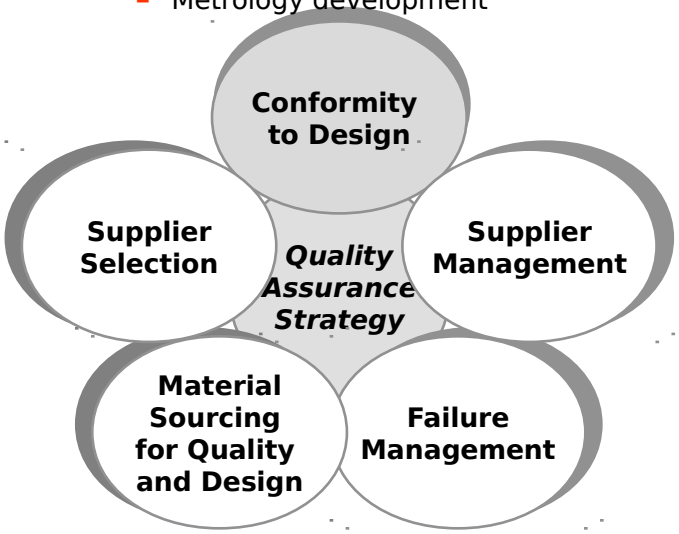
— *Supplier Certification for Ship to Stock* —

Point of Application and Impact on Cycle Time	*Acquisition Timeline*: Origin of Need; Design Specifications Development; Supplier Selection; Start Production; In-Process; End Production; Shipment/ Delivery; Final Use ■ For new contracts, occurs before production begins. For existing contracts, occurs throughout production and final use. ■ Does not impact delivery cycle time of product in new contracts, because it occurs before production begins. ■ For existing contracts, may impact delivery schedule unless production rate is increased to accommodate materials qualification. ■ Does not impact order placement/fulfillment cycle time.
Benefits	**Prevent** ← → **Identify** ■ Shifts responsibility for quality to supplier. ■ Results in reliability and capability data which supplier and buyer can use to identify and address improvement opportunities. ■ Reduces conformity to design requirements, such as incoming or source inspection. ■ Supports just-in-time inventory systems.
Other	■ Use concurrently with sample incoming inspection audits to verify supplier's processes are in control.

— Quality Assurance Method Detail —

Conformity to Design

- Incoming inspection
- Non-delegated source inspection
- Delegated source inspection
- Material qualification
- Acceptance of federal production & type certificates
- Metrology development



World class companies couple supplier certification programs with incoming verification of certificate of conformance documentation and sample inspections of product.

— Incoming Inspection/Acceptance —

Basic Practices	Progressive Practices	World Class Practices
■ Inspection focuses on kind, count and condition of product. ■ Identification of defects occurs during installation or in-service preparation.	■ Inspect product to identify defects and verify conformance to design specifications. ■ Inspection may include use of lab or test equipment for functional, dimensional testing and special characteristics testing.	■ Verification of certificate of conformance or process control documents shipped with product. ■ Sample product inspection at statistically defined intervals. ■ May be limited to certified part numbers or suppliers.

- **Intel Corporation's Silicon Materials and Technology Group** limits its incoming inspection to the a certificate of conformance and statistical process control data for every silicon shipment. Silicon suppliers are certified.
- **Boeing** has suppressed incoming inspection on more than 50% of its inbound materials, allowing it to allocate resources on problem areas.

Once the inspection plans and technical specifications have been developed, the cost of incoming inspection is driven by the intensity of application.

— Incoming Inspection/Acceptance —

Cost Drivers of Implementation

- Engineering Labor
  - *Time and expertise to develop inspection plans, test procedures, and technical specifications.*
- Lab and Test Equipment
  - *Equipment to perform tests.*
- Training
  - *Time and expertise to define required inspection/testing skills*
  - *Time and cost to develop training materials and course outline*
  - *Course presentation costs*
- Information System Infrastructure
  - *Develop automated system to direct inspection type, frequency, and sample size based on supplier certification status and product conformance history*
  - *Develop database for recording and tracking supplier/part performance (defects)*

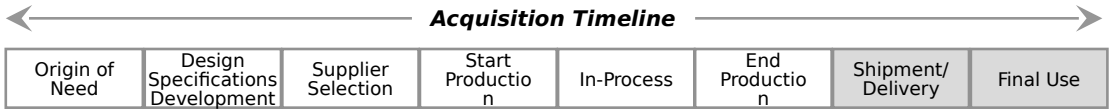
Cost Drivers of Ongoing Application

- Non-Engineering Labor
  - *Time to perform tests and inspections.*
- Lab and Test Equipment
  - *Maintenance and calibration costs of equipment to perform tests.*
- Engineering Labor
  - *Continuous update of inspection plans and technical specifications.*

Incoming inspection does not prevent the production of nonconforming product.

— Incoming Inspection/Acceptance —

Point of Application and Impact on Cycle Time



- Occurs during the shipment/delivery and final use period of the acquisition timeline.
- May increase delivery cycle time depending upon inspection intensity. (queue time for test, test duration, number of tests to be performed)
- No impact on order placement lead time.

Benefits

Prevent ← **Identify**

- Potentially prevents entrance of nonconforming product into the system
- Using inspectors to perform incoming inspection across all commodities reduces costs.

Other

- Use concurrently with supplier certification to verify supplier processes remain in control -- Increase intensity if receive defect from a certified supplier.
- Apply incoming inspection concurrently with supplier implementation of prevent-type quality assurance methods, relaxing intensity as quality performance improves.

Non-delegated source inspection places the responsibility for conformity to design upon the buyer, and therefore has limited application.

— Non-Delegated Source Inspection/Acceptance —

Basic Practices	Progressive Practices	World Class Practices
■ Final inspection of product to verify conformance to design before acceptance.	■ Audit of in-process production to verify that processes are in control. ■ May include verification of control charts and operating parameters of equipment.	■ Sophisticated first article test of product before full production. ■ Performed under circumstances in which alternatives to source inspection are not applicable. ■ Very limited application

- **Boeing's** field representatives only perform final product inspection and in-process audits.
- **Pratt and Whitney's** Supplier Quality Assurance Representatives (SQAR) perform final product inspection and in-process audits.
- **TI equipment** performs source inspection only on the first piece of equipment of a new model.
- **Alaska Airlines** performs "customer acceptance flights" at the source before accepting aircraft.

Source inspection requires highly skilled inspectors dedicated to the field. Therefore, it is difficult to efficiently balance the workload.

— Non-Delegated Source Inspection/Acceptance —

Cost Drivers of Implementation

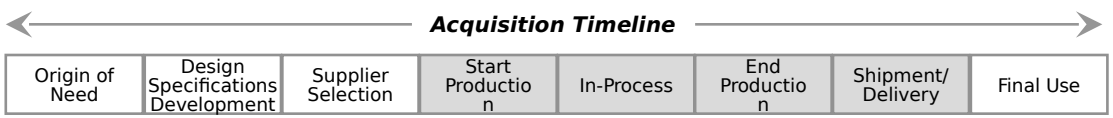
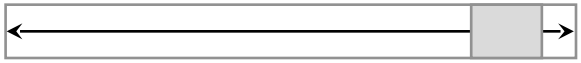
- Engineering Labor
  - *Time and expertise to identify specific inspection points and characteristics to focus on.*
- Training
  - *Time and expertise to define required inspection/testing skills.*
  - *Time and cost to develop training materials and course outlines.*
  - *Course presentation costs*
- Information System Infrastructure
  - *Develop database for recording and tracking supplier part performance (defects) and observations regarding process control.*

Cost Drivers of Ongoing Application

- Non-Engineering Labor
  - *Time to perform tests and inspections at supplier sites*
- Travel Expense
  - *Travel related expenses will vary depending on location, but will most likely be a major cost driver.*
- Engineering Labor
  - *Continuous revision of inspection points and characteristics to focus on.*

Non-delegated source inspection does not prevent the production of nonconforming products nor improve product performance.

— *Non-Delegated Source Inspection/Acceptance* —

Point of Application and Impact on Cycle Time	 ■ Occurs during the production and shipment/delivery periods of the acquisition timeline. ■ Inspection can cause shipment delays that increase delivery cycle time.
Benefits	**Prevent**  **Identify** ■ Immediate feedback to supplier ■ Potentially prevents the entrance of nonconforming product into the system ■ True benefits come from other on-site activities such as technical assessments, root cause analysis, etc.
Other	■ Supplier certification and incoming inspection are alternatives to source inspection. ■ Typically does not build supplier partnerships nor an atmosphere of cooperation. ■ Places responsibility for conformance to design upon the buyer

Delegated source inspection is performed by certified contractor personnel or a third party company.

— Delegated Source Inspection/Acceptance —

Basic Practices	Progressive Practices	World Class Practices
■ Inspection of final product to verify conformity to design.	■ Verification of process control during production by performing in-process product inspections.	■ Verification of process control during production by review of statistical process control data and operating parameters of equipment. ■ Very limited application.

- **GE Aircraft Engine** delegates source inspection and product acceptance to a third party service provider.
- **Pratt & Whitney** delegates source inspection and product acceptance to Quality Assurance Supplier Representatives (QASR), which are certified contractor personnel.
- **Boeing** delegates source inspection to certified contractor personnel per D1-9000.
- The **FAA** delegates source inspection to Designated Manufacturing Inspection Representatives (DMIR).

Delegated source inspection to a supplier's employee requires significant training and trust between companies.

— Delegated Source Inspection/Acceptance —

Cost Drivers of Implementation

- Engineering Labor
  - *Time and expertise to identify specific inspection points and characteristics to focus attention on.*
- Executive Level Partnership Overhead
  - *Requires trust between supplier and buyer.*
- Training
  - *Time and expertise to define required inspection/testing skills for supplier or third party.*
  - *Supplier or third party may be responsible for sourcing and funding training*
- Non-engineering Labor
  - *Time and expertise to develop program criteria and methodology to select, approve, and monitor delegated inspectors.*
  - *Time and expertise to identify conformance data to be provided to buyer, and mode of communication*

Cost Drivers of Ongoing Application

- Non-Engineering Labor
  - *Time to administer program*
- Engineering Labor
  - *Continuous revision of inspection points and characteristics to focus on.*

Delegated source inspection does not prevent the production of nonconforming products nor improve product performance

— *Delegated Source Inspection/Acceptance* —

Point of Application and Impact on Cycle Time	*Acquisition Timeline* Origin of Need | Design Specifications Development | Supplier Selection | Start Production | In-Process | End Production | Shipment/ Delivery | Final Use ■ Occurs during the production and shipment/delivery periods of the acquisition timeline. ■ Inspection or acceptance of product can cause shipment delays, increasing delivery cycle time. ■ No impact on the order placement lead time.
Benefits	**Prevent** ← → **Identify** ■ Potentially prevents entrance of nonconforming product into the system. ■ If delegated to supplier, it places responsibility for conformity to design upon the supplier. ■ Provides alternative for complying with government required inspections (e.g. FAA).
Other	■ If outsourced to a third party, might lose “institutional knowledge” of supplier’s processes.

Advanced applications of material qualification allow the buyer to verify *not only* the supplier's production capability, *but also* the performance and design specification.

— Material Qualification —

Basic Practices	Progressive Practices	World Class Practices
■ Perform first article inspections to verify supplier's ability to produce to design specifications.	■ Perform field testing to verify the performance of new products designed by suppliers. ■ Prototype testing allows the buyer to gain insight into new technologies, and provide feedback to the supplier. Supplier uses the data to improve processes and product features.	■ Perform prototype testing to develop and verify performance specifications of new products. ■ Specification jointly developed and verified by supplier and buyer. Continuous exchange of information between supplier and buyer. ■ May include early raw material characteristic certification.

- **Intel Corporation's Silicon Materials and Technology Group** works closely with suppliers to approve silicon wafers manufactured using new technologies.
- **Ryder** uses field tests to gain a competitive advantage over its competitors.
- **Toyota Motor Company** uses prototype testing as part of R&D activities to improve quality.
- **Pratt & Whitney** Laboratory Control at Source (LCS) shifts the responsibility to the supplier, while maintaining control of outsourced lab testing.

Material qualification demands significant implementation costs. Ongoing costs are driven by the frequency of application.

— Material Qualification —

Cost Drivers of Implementation

- Lab and Test Equipment
  - *Equipment and facilities to perform qualification tests.*
- Information Systems Infrastructure
  - *Database to track qualification results.*
  - *Data to perform analysis.*
- Engineering Labor
  - *Time and expertise to identify critical characteristics and develop test methodologies.*

Cost Drivers of Ongoing Application

- Engineering Labor
  - *Perform tests and analyze data.*
- Information Systems Infrastructure
  - *Maintenance of data to perform comparative analysis.*
- Lab and Test Equipment
  - *Maintenance and calibration costs of equipment to perform tests.*
- Non-Engineering Labor
  - *Time required to witness tests and administer qualification process.*

Supplier and buyer each increase visibility/understanding of product and process limitations while performing material qualification.

— *Material Qualification* —

Point of Application and Impact on Cycle Time	*Acquisition Timeline* Origin of Need | Design Specifications Development | Supplier Selection | Start Production | In-Process | End Production | Shipment/ Delivery | Final Use ■ Occurs throughout the design specifications development to start production periods of the acquisition timeline. ■ Reduction in defect rate may reduce delivery cycle time. ■ The time required to perform the material qualification will have a significant impact on, and may increase, the order placement/fulfillment cycle time.
Benefits	**Prevent** ← → **Identify** ■ Reduced “black space”, defined as the unknown characteristics/variables of the specific product or process. ■ Reduced defect rate. ■ Supports supplier certification.
Other	■ Supports supplier certification.

Federal Aviation Administration certificates reduce the quality assurance burden of the aerospace buyer.

— Acceptance of Federal Certifications —

Basic Practices	Progressive Practices	World Class Practices
■ Maintenance Shops: Airlines accept FAA certification of maintenance shops, but conduct own audits to fulfill federal surveillance requirement.	■ Maintenance Shops: Airlines accept FAA certification of maintenance shops, but fulfill federal surveillance requirement by using CASE audits as well as own audits. ■ Components/Spares: Additional random product audits on top of FAA airworthiness certificate.	■ Maintenance Shops: Airlines accept FAA certification of maintenance shops, and fulfill federal surveillance requirement only by using CASE approved shops. ■ Components/Spares: Accept product based on verification of FAA airworthiness certificate.

- **Northwest Airlines** accepts FAA certification of maintenance shops.
- **Alaska Airlines** accepts FAA's airworthiness certificate for new aircraft and production certifications for spares. Alaska does not perform any safety related inspections on these products.
- **Boeing** accepts FAA's airworthiness certificate for aircraft engines.

The direct cost to the buyer of accepting FAA certificates is minimal.

— Acceptance of Federal Certifications —

Cost Drivers of Implementation	Cost Drivers of Ongoing Application
■ Non-Engineering Labor • *Minimal time to set up program.*	■ Non-Engineering Implementation Labor • *Incoming inspectors review authenticity and content of FAA certificates.*

FAA certificate places the responsibility for safety with the certificate holder.

— Acceptance of Federal Certifications —

Point of Application and Impact on Cycle Time	***Acquisition Timeline*** → Origin of Need | Design Specifications Development | Supplier Selection | Start Production | In-Process | End Production | Shipment/ Delivery | Final Use ■ Occurs during shipment/delivery period of the acquisition timeline. ■ Incoming inspection occurs concurrently to kind, count and condition and does not impact delivery cycle time. ■ Does not impact order placement/fulfillment cycle time.
Benefits	**Prevent** ← → **Identify** ■ Minimizes quality assurance costs . ■ Places the responsibility for safety with the certificate holder.
Other	■ Only applies to FAA designated parts.

Metrology development is the joint development of performance metrics and new testing methods to provide buyers and suppliers with valuable information.

— Metrology Development —

Basic Practices	Progressive Practices	World Class Practices
■ Use standard industry metrics to measure product performance or conformity to design.	■ Use of recent non-conformance data to develop checklists of possible defects. These checklists guide inspectors to verify the elimination of recent problems. Also provides the supplier with a template of how their product will be inspected for acceptance/rejection.	■ Joint development of performance metrics and testing methods. ■ For emerging technologies, the expertise of specific characteristics may reside with the supplier or buyer.

- **Intel Corporation's Silicon Materials and Technology Group** jointly develops methods with suppliers ways to test the performance specification of the new 300 mm diameter wafers.
- **Pratt & Whitney** continuously develops inspection checklists with the latest non-conformances found during the inspection process.

Joint metrology development occurs on a continuous basis and requires additional engineering resources for new products or specifications improvements.

— Metrology Development —

Cost Drivers of Implementation

- Lab and Test Equipment
  - *Equipment required to conduct tests.*
- Information Systems Infrastructure
  - *Data to conduct analysis*
- Engineering Labor
  - *Time and expertise to develop implementation plan, coordinating activities.*
- Executive Level Partnership Overhead
  - *Efforts to develop close relationships with suppliers.*

Cost Drivers of Ongoing Application

- Engineering Labor
  - *Time and expertise to analyze data and conduct tests.*
- Lab and Test Equipment
  - *Equipment required to conduct tests.*
- Information Systems Infrastructure
  - *Data to conduct analysis*

The use of jointly developed testing methods and metrics will allow the buyer to provide suppliers with better feedback to improve products or processes.

— Metrology Development —

Point of Application and Impact on Cycle Time	*Acquisition Timeline* Origin of Need | Design Specifications Development | Supplier Selection | Start Production | In-Process | End Production | Shipment/ Delivery | Final Use ■ Occurs during the design specification development and production through shipment/delivery periods of acquisition cycle time. ■ No impact on delivery cycle time. ■ Joint metrology development activities may increase the order placement/fulfillment cycle time.
Benefits	**Prevent** ← → **Identify** ■ Improved methodology to measure and test new product allows the buyer to give the supplier better feedback that supplier can use to improve processes. ■ Enables buyer and supplier to jointly determine appropriate metrics. ■ Align incentives of supplier to objectives of buyer.
Other	■ The alternative to develop own testing methods and metrics will most likely result in limited use feedback to supplier.

— Quality Assurance Method Detail —

Supplier Management

- Recognition of good and bad performance
- Rationalization of supplier base
- Ongoing supplier qualification
- Feedback to suppliers
- Supplier development

Not all companies reward suppliers based upon performance, but most recognize bad performance with a corrective action system.

— Performance Recognition—

Basic Practices	Progressive Practices	World Class Practices
■ Corrective action system to document bad performance.	■ Corrective action system. ■ Develop supplier awards, such as 'supplier of the year,' which may be based upon volume, delivery or performance. Awards are granted every year based on relative performance.	■ Develop supplier awards which are prestigious and have limited distribution, based on stringent criteria. Awards are not be granted every year and are based on absolute performance. ■ Rewards may include increased business allocation for good performance, relative to that of other suppliers. Opposite is true for bad performance.

- **Intel Corporation** re-allocates silicon business twice a year based on relative supplier performance.
- **Intel Corporation** penalizes silicon caused yield excursions by disqualifying the part number for one year.
- **Intel Corporation's** most prestigious supplier award, the Supplier Continuous Quality Improvement award, allows suppliers to identify themselves as Intel suppliers and includes recognition in premier business publications.
- **Texas Instruments** direct materials deletes supplier's with poor performance from the qualified supplier list.

Once the performance recognition criteria and format is developed, the cost is driven by frequency and size of supplier base.

— Performance Recognition—

Cost Drivers of Implementation	Cost Drivers of Ongoing Application
■ Engineering Labor • *Time and quality engineering expertise to develop recognition criteria and outcomes.* ■ Information System Infrastructure • *Database and data analysis to support development of criteria.*	■ Non-Engineering Labor • *Time to compile performance data.* • *Time to deliver performance recognition and implement outcomes.* ■ Information System Infrastructure • *Database and data analysis to support compilation of performance data to criteria.* ■ Other • *Physical recognition object, such as award or advertisement.*

World class applications of performance recognition seek to prevent the production of nonconforming products.

— Performance Recognition —

Point of Application and Impact on Cycle Time	***Acquisition Timeline*** → Origin of Need | Design Specifications Development | Supplier Selection | Start Production | In-Process | End Production | Shipment/ Delivery | Final Use ■ Occurs at supplier selection and final use. ■ Does not impact delivery cycle time of product, unless contract is terminated. ■ Does not impact order placement lead time.
Benefits	**Prevent** ← → **Identify** ■ World class applications will motivate suppliers to improve performance and prevent production of nonconforming product. ■ Ensures that supplier and buyer have same understanding of performance expectations and outcomes.
Other	■ The format and criteria of recognition may be based upon supplier feedback templates. ■ Performance recognition may be the outcome of supplier feedback practices.

Value-added applications of supplier base rationalization increase the buyer's influence over the quality and performance levels of the product.

— Rationalization of Supplier Base —

Basic Practices	Progressive Practices	World Class Practices
■ Unmanaged proliferation of supplier base. ■ Multiple suppliers of same part number.	■ Consolidation of supplier base in order to extract lower costs and increased buyer power.	■ Consolidation results in reduced system variability and overhead costs. ■ Consolidation enables buyer to allocate supplier development and joint product development resources among a smaller number of suppliers. ■ Consolidation may or may not result in lower direct costs. ■ Consolidation results in increased buyer power to demand higher performance and quality products.

- **Ryder Transportation Services** rationalized its supplier base concurrently to a reduction in specification configurations and part numbers.
- **Toyota Motor Company's** suppliers are so tightly integrated into the Toyota Production System that proliferation of the supplier base is prevented.

The cost of rationalization of the supplier base is driven by the time and expertise required to make the rationalization decisions.

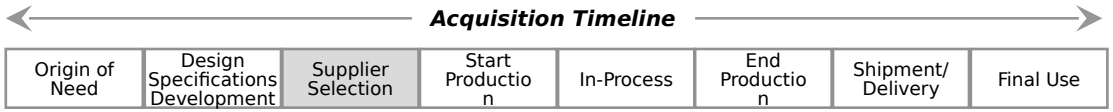
— Rationalization of Supplier Base —

Cost Drivers of Implementation	Cost Drivers of Ongoing Application
■ Engineering Labor • *Time and expertise to support development of rationalization criteria and outcomes.* ■ Non-Engineering Labor • *Time to develop rationalization criteria and outcomes.* • *Time to administer rationalization.* ■ Information System Infrastructure • *Database and data analysis to support rationalization criteria and outcomes.*	*Not Applicable* *Rationalization is typically a special project, versus an activity accomplished on an ongoing basis*

Rationalization of the supplier base will reduce system variability by reducing the number of sources.

— Rationalization of Supplier Base —

Point of Application and Impact on Cycle Time



- Occurs during the supplier selection period of the acquisition timeline.
- Reduction in system variability and number of suppliers may reduce delivery cycle time.
- Does not impact order placement lead time.

Benefits

- Reduction in system variability may result in reduction of nonconforming product.
- Increases supplier power to influence price, quality, performance and delivery.
- Reduction in number of suppliers will result in reduction of procurement overhead costs.

Other

- May occur concurrently with part rationalization.

Methods for ongoing supplier qualification range from formalized annual audit processes to subtle, continuous flows of information and communication between the buyer and supplier.

— Ongoing Supplier Qualification —

Basic Practices	Progressive Practices	World Class Practices
■ Accept renewal of ISO9000 certification as criteria for ongoing supplier qualification.	■ Perform quality system and product audit to customized criteria at set frequency. ■ Audit format may be similar to that performed for supplier qualification, but is applied with less severity.	■ Quality and frequency of communication with supplier results in lack of need to perform ongoing supplier qualification. ■ Buyer continuously has all information necessary to maintain qualification from the partnership nature of the buyer-supplier relationship. ■ Supplier feedback, early supplier involvement and joint product development actives support buyer-supplier relationships.

- **Toyota Motor Company** is so tightly integrated with its supplier base that it does not justify a formalized ongoing supplier qualification program.
- **Ryder Transportation Services'** new vehicle quality manager spends the majority of his time in the field and informally performs ongoing supplier qualification.

The cost of ongoing supplier qualification is driven by the required frequency and size of the supplier base.

— Ongoing Supplier Qualification —

Cost Drivers of Implementation

- Engineering Labor
  - *An integral part of the supplier qualification program definition*
  - *Time and expertise of quality or manufacturing engineers to define the process, method and frequency for ongoing maintenance of supplier certification*
- Training
  - *An integral part of supplier qualification training for audit personnel*

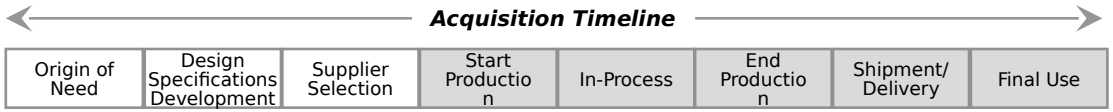
Cost Drivers of Ongoing Application

- Engineering Labor & Non-engineering Labor
  - *Time to coordinate and prepare for qualification audit.*
  - *Time and expertise to conduct qualification audit.*
  - *Time to document and follow-up on qualification audit.*
- Travel Expense
  - *Travel to and from supplier site.*

Ongoing supplier qualification enables the buyer to verify the processes of the supplier are in control.

— *Ongoing Supplier Qualification* —

Point of Application and Impact on Cycle Time



- Occurs throughout production and final use.
- Does not impact delivery cycle time.
- Does not impact order placement lead time.

Benefits

- Enables buyer to verify that supplier processes are in control.
- Standardized process supports efficient supplier management.
- Enables buyer to identify opportunities for improvement within the suppliers system.

Other

- Frequency may be affected by geography of supplier base in order to reduce travel expenses.

World class companies provide feedback to suppliers to motivate and enable them to improve product quality and performance. Suppliers are provided the information to identify the next performance level target.

— Feedback to Suppliers —

Basic Practices	Progressive Practices	World Class Practices
■ No formal or scheduled feedback shared with suppliers. ■ Corrective action system to document bad performance.	■ Specified feedback shared with individual suppliers. For example, supplier report card provided at set frequency. ■ Feedback may include acceptance rate, delivery performance and failure rate. ■ Feedback potentially tied or traced directly to corporate goals.	■ Specified feedback shared with suppliers in aggregate with individual performance shared only with that supplier. For example, supplier scorecard provided at set frequency. ■ Format is commodity specific. ■ Feedback may include acceptance rate, delivery performance, failure rate, product performance, trends and volume. ■ Aggregate performance shared to demonstrate quality levels being achieved by other suppliers, so that all suppliers know what is possible. ■ Specified feedback tied to corporate goals.

- **Intel Corporation's Silicon Materials and Technology Group** produces a silicon scorecard twice a year and uses it to allocate business. Intel also produces a monthly silicon status report.
- **Pratt & Whitney** compiles a monthly supplier report card, of which elements are rolled up into corporate quality report cards.
- **Texas Instruments** compiles a CETRAQ report for each supplier every six months which includes metrics specific to cost, environmental compliance, technology, responsiveness and assurance of supply and quality.

The cost of supplying feedback to suppliers is driven by the level of detail.

— Feedback to Suppliers —

Cost Drivers of Implementation

- Engineering Labor
  - *Time and expertise of quality or manufacturing engineers to develop feedback and rating criteria.*
- Information System Infrastructure
  - *Time to locate information sources for desired metrics, and assessment areas*
  - *Time to develop the plan for compiling required data (software purchase, report development, resource allocation to manually compile, etc.)*

Cost Drivers of Ongoing Application

- Non-Engineering Labor
  - *Time to compile feedback data.*
  - *Time to deliver feedback to suppliers.*
- Information System Infrastructure
  - *Database and data analysis to support compilation of data.*
- Travel Expense
  - *Travel to and from site of supplier.*
- Executive Level Partnership Overhead
  - *Requires suppliers to be receptive to feedback.*

For quality performance to be improved, the supplier must be receptive to the feedback and take action to improve.

— *Feedback to Suppliers* —

Point of Application and Impact on Cycle Time	*Acquisition Timeline* Origin of Need | Design Specifications Development | Supplier Selection | Start Production | In-Process | End Production | Shipment/ Delivery | Final Use ■ Occurs throughout production and final use. ■ Does not impact delivery cycle time. ■ Does not impact order placement lead time.
Benefits	**Prevent** ← → **Identify** ■ World class applications will enable and motivate suppliers to improve performance by making them aware of the high bar of performance currently being delivered within the commodity. ■ Ensures that supplier and buyer have same understanding of performance expectations and outcomes.
Other	■ The format and criteria of recognition may be based upon supplier feedback templates. ■ Performance recognition awards may be based on supplier ratings.

Supplier development is one of the most advanced methods of quality assurance; requiring buy-in and support at the corporate executive level.

— Supplier Development —

Basic Practices	Progressive Practices	World Class Practices
■ Do not engage or invest in supplier development activities, even if process or quality improvement opportunities existed.	■ Provides training and counseling to the supplier for process and quality improvement. May be a pre-existing training program, or specialized training developed for supplier base. ■ Buyer bears cost of training activities. ■ Will deploy quality and engineering expertise to assess supplier's processes, but will not engage formal improvement program.	■ Develop teams dedicated to supplier development activities for process and quality improvement. Teams are comprised of highly qualified design and quality engineers. ■ The costs and benefits of improvement engagements are shared between the buyer and supplier. ■ Mutual agreement between buyer and supplier to send a development team; not forced upon supplier by buyer. ■ Will provide capital investments or loans to supplier to support quality or process improvement activities.

- **General Electric's** 'Black Belt' teams are famous for their success at conducting quality and process improvement activities and are composed of highly experienced manufacturing, design and quality engineers.
- **Raytheon TI's** Continuous Flow Manufacturing (CFM) teams are similar to GE's Black Belts, but have not been deployed as extensively.

Supplier development has a high return on investment because it results in quality or process improvement.

— Supplier Development —

Cost Drivers of Implementation

- Engineering Labor
  - *Time and quality/manufacturing engineering expertise to evaluate development opportunities.*
- Non-Engineering Implementation Labor
  - *Time and finance expertise to evaluate development opportunities.*
- Executive Level Partnership Overhead
  - *Requires committed relationship with supplier.*
- Travel Expense
  - *Travel to and from site of supplier.*

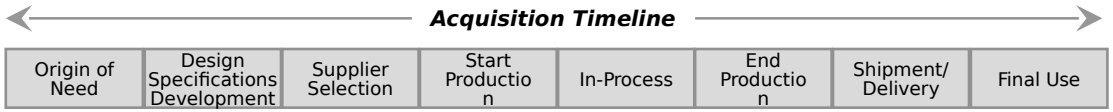
Cost Drivers of Ongoing Application

- Engineering Labor
  - *Time and quality/manufacturing engineering expertise to conduct development projects.*
- Non-Engineering Labor
  - *Time of quality and acquisition specialists to support development projects.*
- Other
  - *May require financial investment.*
- Lab and Test Equipment
  - *Equipment to support and verify development project.*
- Information System Infrastructure
  - *Database and data analysis to support project.*
- Executive Level Partnership Overhead
  - *Requires committed relationship with supplier.*
- Travel Expense
  - *Travel to and from site of supplier.*

The objective of supplier development is to prevent the production of nonconforming products and to improve supplier performance.

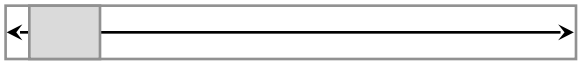
— *Supplier Development* —

Point of Application and Impact on Cycle Time



- Occurs throughout the acquisition timeline.
- Reduction in defect rate may reduce cycle time.
- Does not impact order placement lead time.

Benefits



- Results in quality or process improvement of supplier's production process.
- May result in improved price, nonconformance rate or product application performance.
- Strengthens relationship with supplier.
- Increases knowledge exchange between supplier and buyer.

Other

- May reduce need for conformity to design quality assurance methods.
- Need may be triggered by a negative performance trend
- Often a component or result of supplier qualification or certification activities (including ongoing supplier certification)

The International Journal of Purchasing and Materials Management surveyed purchasing executives within the National Association of Purchasing Management (NAPM) to identify the most common supplier development activities.

Rank	Supplier Development Activity	Mean
1	Providing feedback to supplier	2.01
2	Inviting supplier's personnel	2.25
3	Site visits	2.62
4	Verbal or written corrective action request	2.66
5	Promise of future benefits	2.72
6	Formal evaluation of supplier's performance	2.80
7	Use of 2 or 3 suppliers	2.88
8	Informal evaluation of supplier's performance	2.90
9	Promise of current benefits	3.12
10	Supplier certification program	3.44
11	Supplier recognition	3.74
12	Training of supplier personnel	3.80
13	Use of 4 or more suppliers	4.32
14	Investment in supplier's operation	4.66

Key
1 = always 2 = often 3 = sometimes 4 = seldom

Source: *Supplier Development: Current Practices and Outcomes*, *International Journal of Purchasing and Materials Management*, Spring 1997

The following definitions were used to conduct the survey.

— Supplier Development Activities —

- Providing supplier with **feedback** about the results of its evaluation.
- **Inviting supplier's personnel** to your site to increase their awareness of how their product is used.
- **Site visits** by your firm to supplier's premises to help supplier improve its performance.
- **Verbal or written request** that the supplier improve its performance.
- **Promise of future benefits**, such as consideration for future business.
- Assessment of supplier's performance through **formal evaluation**, using established guidelines and procedures.
- **Use of 2 or 3 suppliers** for this purchased item to create competition among suppliers.
- Assessment of supplier's performance through **informal evaluation**, which takes place on an ad-hoc basis with no set procedures.
- **Promise of current benefits**, such as a higher volume order of the present item.
- Use of a supplier **certification program** to certify supplier's quality, thus making incoming inspection unnecessary.
- **Recognition** of supplier's achievements/performance in the form of awards.
- **Training/education** of the supplier's personnel.
- **Use of 4 or more suppliers** for this purchased item to create competition among suppliers.

Source: *Supplier Development: Current Practices and Outcomes*
International Journal of Purchasing and Materials
Management, Spring 1997

The benefits realized from the supplier development activities were also reported.

— Respondents' Estimate of the Supplier's Performance —

Criteria	Before Supplier Development	Today	Estimated Change Due to Supplier Development
1. Incoming defects	11.65%	5.45%	75.91%
2. Percent on-time delivery	79.85%	91.02%	79.24%
3. Cycle time (from order placement to receipt, inclusively)	35.74 days	23.44 days	15.80 days
4. Percent orders received complete	85.47%	93.33%	78.34%

Source: *Supplier Development: Current Practices and Outcomes, International Journal of Purchasing and Materials Management, Spring 1997*

— Quality Assurance Method Detail —

Material Sourcing for Quality and Design

- Root cause analysis and resolution
- Part rationalization
- Early supplier involvement
- Joint product development

Root cause analysis and resolution are used to identify and address process and quality improvement opportunities.

— Root Cause Analysis and Resolution —

Basic Practices	Progressive Practices	World Class Practices
■ Neither tracks nor investigates defect and failure occurrences, thereby eliminating ability for root cause analysis and resolution. ■ Does not require suppliers to use statistical process control techniques to monitor and measure process performance.	■ Tracks defect and failure occurrences, but does not perform root cause analysis. ■ Does not require suppliers to use statistical process control techniques to monitor and measure process performance.	■ Works with supplier to track product performance data and to perform root cause analysis. ■ Continuously analyzes data for defect, performance or failure trends. ■ Requires supplier to submit process control data with each shipment. ■ Continuously analyzes process control data for performance trends.

- **Alaska Airlines** tracks and analyzes repair work and field longevity of each part to identify performance trends and shares the data with the aircraft manufacturer for quality and process improvement.
- **Ryder Transportation Services** is implementing an extensive root cause analysis program which will support its scheduled failure and preventive maintenance strategy.
- **Intel Corporation's Silicon and Materials Technology** group performs stringent root cause analysis on all silicon yield excursions.

The cost of root cause analysis and resolution is driven by the intensity and frequency.

— Root Cause Analysis and Resolution —

Cost Drivers of Implementation

- Engineering Labor
  - *Time and expertise to develop analysis process and procedures*
- Non-Engineering Labor
  - *Time to support implementation.*
- Information System Infrastructure
  - *Requires implementation of a database to track failure data, as well as analysis tools.*
- Lab and Test Equipment
  - *Equipment to verify resolution*
- Executive Level Partnership Overhead
  - *Requires close coordination with and cooperation from suppliers.*

Cost Drivers of Ongoing Application

- Engineering Labor
  - *Time and engineering expertise to perform analysis and determine resolution.*
- Information System Infrastructure
  - *Maintenance of database to support root cause analysis.*
- Lab and Test Equipment
  - *Maintenance and calibration of equipment to verify resolution.*
- Non-Engineering Labor
  - *Time to support analysis and resolution.*
- Executive Level Partnership Overhead
  - *Requires close coordination with and cooperation from receptive suppliers.*

Supplier must be receptive to root cause analysis in order to reduce the rate of nonconformance.

— Root Cause Analysis and Resolution —

Point of Application and Impact on Cycle Time	*Acquisition Timeline*: Origin of Need; Design Specifications Development; Supplier Selection; Start Production; In-Process; End Production; Shipment/ Delivery; Final Use ■ Occurs throughout production. ■ Reduction in nonconformance rate may reduce delivery cycle time. ■ Does not impact order placement lead time.
Benefits	**Prevent** ← → **Identify** ■ Enables buyer and supplier to identify opportunities for improvement. ■ Increases knowledge exchange between buyer and supplier. ■ May result in reduction in nonconformance rate or improved product performance.
Other	■ May reduce need for conformity to design quality assurance methods.

Part rationalization usually requires a reduction in configuration options of the final product or service offering, and results in reduced system variability.

— Part Rationalization —

Basic Practices	Progressive Practices	World Class Practices
■ Unmanaged proliferation of part numbers and specification configurations. ■ More than 2 or 3 part numbers which can substitute one another.	■ Reduction of part numbers in order to reduce direct product costs.	■ Rationalization results in reduced system variability and overhead costs. ■ Rationalization may or may not result in lower direct costs. ■ Rationalization results in consolidation of supplier base and increased buyer power to demand higher performance and quality products.

- **Ryder Transportation Services** rationalized its part numbers concurrently to a reduction in specification configurations and and qualified suppliers.
- The **Toyota** Production System (TPS) prevents the proliferation of part numbers and specification configurations.
- **Texas Instruments** rationalized its part numbers based upon materials qualification and capability.

Like rationalization of the supplier base, the cost of part rationalization is driven by the time and expertise required to make the rationalization decisions.

— Part Rationalization —

Cost Drivers of Implementation

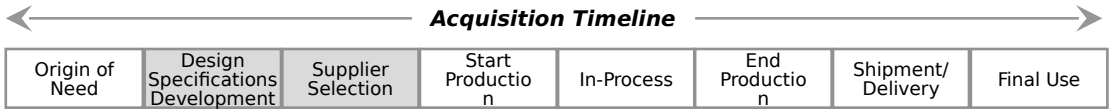
- Engineering Labor
  - *Time and expertise to support development of rationalization criteria and outcomes.*
- Non-Engineering Labor
  - *Time to develop rationalization criteria and outcomes.*
  - *Time to administer rationalization.*
- Information System Infrastructure
  - *Database and data analysis to support rationalization criteria and outcomes.*

Cost Drivers of Ongoing Application

- Non-Engineering Labor.
  - *Time to maintain database.*

Part rationalization reduces system variability and ensures only qualified parts are used in the design process.

— Part Rationalization —

Point of Application and Impact on Cycle Time	 ■ Occurs during design specifications development and supplier selection. ■ Does not impact delivery cycle time. ■ Potentially reduces order fulfillment cycle time.
Benefits	 ■ Controls the quality of part numbers used in design phase. ■ Reduction in system variability may improve quality reliability, resulting in the reduction of nonconforming product. ■ Reduction in qualified part numbers will result in reduction of procurement overhead costs.
Other	■ May occur concurrently with rationalization of the supplier base.

Early supplier involvement provides the supplier more lead time to verify and/or build capability to fulfill future demands from both volume and technology perspectives.

— Early Supplier Involvement —

Basic Practices	Progressive Practices	World Class Practices
■ Forecasted volume or technology needs not provided to supplier.	■ Provides volume forecast on a medium term, need to know, basis to supplier.	■ Provides forecasted volume and technology needs on a long term basis to supplier. ■ Performs forecasting jointly with supplier. ■ Requires forecasting expertise.

- **Intel Corporation's Silicon Materials and Technology Group** provides its suppliers with next generation technology demands immediately upon identification, as well as continuous volume forecasts for current part numbers.
- **Texas Instruments** is currently implementing an extensive early supplier involvement program with its fabrication equipment suppliers.

Early supplier involvement requires extensive engineering participation if product technology is rapidly advancing.

— Early Supplier Involvement —

Cost Drivers of Implementation

- Non-Engineering Labor
  - *Expertise to develop forecasting methods.*
- Information System Infrastructure
  - *Database and data analysis to support development of forecasting methods.*
- Executive Level Partnership Overhead
  - *Requires committed relationship and close coordination with supplier.*

Cost Drivers of Ongoing Application

- Engineering Labor
  - *Time and expertise to forecast future performance requirements.*
- Non-Engineering Labor
  - *Time and expertise to forecast volume requirements.*
  - *Time and marketing expertise to forecast technology requirements.*
- Information System Infrastructure
  - *Database and data analysis to perform forecasting.*
- Travel Expense
  - *Travel to and from site of supplier.*
- Executive Level Partnership Overhead
  - *Requires committed relationship and close coordination with supplier.*

Early supplier involvement strengthens the partnership between the buyer and supplier.

— Early Supplier Involvement —

Point of Application and Impact on Cycle Time	***Acquisition Timeline*** → Origin of Need | Design Specifications Development | Supplier Selection | Start Production | In-Process | End Production | Shipment/ Delivery | Final Use ■ Occurs throughout acquisition timeline. ■ Does not impact delivery cycle time. ■ Will become part of the lead time before an order can be placed. World class companies anticipate and plan for this lead time
Benefits	**Prevent** ← → **Identify** ■ Provides supplier more lead time to build and verify capability to fulfill future demands for both volume and technology. ■ Increases knowledge exchange between buyer and supplier. ■ Strengthens relationship with supplier.
Other	■ Assumes a long term relationship with the supplier.

By engaging suppliers in product development partnerships, buyers can ensure quality and performance are built into the product design.

— Joint Product Development —

Basic Practices	Progressive Practices	World Class Practices
■ Does not develop products jointly with supplier. ■ Controls design specifications and expertise.	■ Will engage in joint product development activities on a very limited basis and will not commit extensive resources. ■ Allows supplier to control design specifications and expertise.	■ Pro-actively engages suppliers in product development partnerships. ■ Rewards suppliers that add value to the product development process.

- **Intel Corporation** requires and motivates its suppliers to continuously engage in joint product development activities, such as the new 300 mm diameter silicon wafer.
- **Toyota Motor Company** also requires and motivates its suppliers to engage in joint product development.

The cost of joint product development is driven by the complexity of the product, and justified by the strategic value received.

— Joint Product Development —

Cost Drivers of Implementation

- Non-Engineering Labor
  - *Time and marketing/procurement expertise to design joint product development process.*
- Executive Level Partnership Overhead
  - *Requires close coordination with and cooperation from receptive suppliers.*
- Information Systems Infrastructure
  - *Time to identify coordination requirements and systems solutions*
  - *Cost of software/hardware to allow extensive coordination of product design, configuration and interfaces; if required*

Cost Drivers of Ongoing Application

- Engineering Labor
  - *Time and expertise to develop new product design and specification and support joint development process.*
- Lab and Test Equipment
  - *Equipment required to test product design and specification.*
- Non-Engineering Labor
  - *Time and marketing expertise to develop new product specifications and support joint development process.*
- Travel Expense
  - *Travel to and from supplier site.*
- Executive Level Partnership Overhead
  - *Requires close coordination with and cooperation from receptive suppliers.*

Buyers can expect high levels of product and supplier performance to result from joint product development.

— Joint Product Development —

Point of Application and Impact on Cycle Time	***Acquisition Timeline*** → Origin of Need | Design Specifications Development | Supplier Selection | Start Production | In-Process | End Production | Shipment/ Delivery | Final Use ■ Occurs throughout the origin of need through the start of production. ■ Does not impact delivery cycle time. ■ Potentially reduces order fulfillment cycle time.
Benefits	**Prevent** ← → **Identify** ■ Buyer can ensure that quality is built into the product design. ■ Buyer can expect high levels of product and supplier performance. ■ Increases knowledge exchange between supplier and buyer. ■ Strengthens relationship with supplier.
Other	■ Assumes long term relationship with supplier.

— Quality Assurance Method Detail —

Failure Management

- On-site technical supplier support
- Return of defective parts under warranty
- Failure tracking

On-site technical support gives suppliers direct feedback about field failures and problems, and enables the supplier to strengthen the relationship with the end user.

— On-site Technical Supplier Support —

Basic Practices	Progressive Practices	World Class Practices
■ On-site technical supplier support representatives assist field personnel in resolving problems.	■ Data collected from the on-site technical supplier support group is shared with the buyer to develop strategies to minimize the impact of failures in the field.	■ Data collected from the on-site technical supplier support group is used by the supplier to identify problem areas, and a root cause analysis is used to correct the problem.

- **Ryder's** strategic partner suppliers have agreed to station technical support people to assist field personnel. Supplier's technical representatives costs, including payroll and housing, are paid for by the suppliers.

Suppliers usually pick up the tab to set-up an on-site technical assistance center to aid field personnel.

— On-site Technical Supplier Support —

Cost Drivers of Implementation

- Other
  - *Physical space overhead costs.*
- Information Systems Infrastructure
  - *Database with failure data*
  - *Supplier support tracking system*
- Executive Level Partnership Overhead
  - *Develop close relationship between companies.*

Cost Drivers of Ongoing Application

- Non-Engineering Labor
  - *Administration time of supplier technical representatives.*
- Engineering Labor
  - *Joint analysis of failure data.*
- Executive Level Partnership Overhead
  - *Maintain close relationship between companies.*

World class applications will result in a feedback loop that suppliers use to gather field performance data to improve product design and manufacturing processes.

— On-site Technical Supplier Support —

Point of Application and Impact on Cycle Time	*Acquisition Timeline* Origin of Need | Design Specifications Development | Supplier Selection | Start Production | In-Process | End Production | Shipment/ Delivery | Final Use ■ Occurs in the final use period of the acquisition timeline. ■ Does not impact delivery cycle time. ■ No impact on the order placement lead time.
Benefits	**Prevent** ← **Identify** ■ Buyer is using the technical expertise of the supplier to solve problems in the field. ■ Supplier gains direct information about what is happening in the field. This data can potentially be used to improve product quality to minimize future field problems . ■ Strengthens the relationship between supplier and buyer.
Other	■ Assumes mutual interest in a long term relationship.

The return of defective parts under warranty is not a world class quality assurance method.

— Return of Defective Parts Under Warranty —

Basic Practices	Progressive Practices	World Class Practices
■ Notify supplier of warranty claims. ■ Return defective parts under warranty so that the supplier can analyze them and find the root cause to eliminate it.	■ Use warranty claim information to identify poor suppliers, adverse trends, and initiate corrective action.	

- **BNSF** uses a computerized system that tracks warranty data to identify poor suppliers and initiate corrective action.
- **Ryder** is authorized to perform own warranty work and charge it back to supplier.

A significant investment is needed to set-up a sophisticated warranty claim system.

— Return of Defective Parts Under Warranty —

Cost Drivers of Implementation

- Non-Engineering Labor
  - *Development of warranty claims administrative system.*
- Information System Infrastructure
  - *Time to develop and cost to implement a system to track failures and warranty claims.*

Cost Drivers of Ongoing Application

- Non-Engineering Labor
  - *Administration of warranty claim system and return of defective parts from the field.*

However, the warranty claim information might prove useful to suppliers to gauge field performance of their products.

— Return of Defective Parts Under Warranty —

Point of Application and Impact on Cycle Time	***Acquisition Timeline*** → Origin of Need | Design Specifications Development | Supplier Selection | Start Production | In-Process | End Production | Shipment/ Delivery | Final Use ■ Occurs during the delivery and final use periods of the acquisition timeline. ■ No impact on the delivery cycle time. ■ No impact on order placement lead time.
Benefits	**Prevent** ← **Identify** ■ Suppliers can perform root cause analysis using returned parts or warranty claim data, potentially initiating corrective action to minimize future non-conformances and reduce warranty claim costs.
Other	■ Places responsibility of conformance to design on the buyer.

The value of failure tracking is to provide the data needed to perform root cause analysis.

— Failure Tracking —

Basic Practices	Progressive Practices	World Class Practices
■ Track failures at incoming inspection and field.	■ Data from incoming inspection, field failures and other Quality Assurance data is used to identify adverse trends and initiate corrective action with suppliers.	■ Failure Reporting, Analysis, and Corrective Action System (FRACAS) is a closed-loop feedback path in which the user and the supplier work together to collect, record, and analyze failures of both hardware and software data sets.

- **Texas Instruments** fabrication equipment uses FRACAS to capture historical reliability performance data and work with suppliers to resolve issues.

A comprehensive data collection system is the significant cost driver of failure tracking.

— Failure Tracking —

Cost Drivers of Implementation

- Information System Infrastructure
  - *Time to design and cost to implement a data collection system to record, store and process failure data.*
- Engineering Labor
  - *Design, planning and administration of failure tracking system.*

Cost Drivers of Ongoing Application

- Engineering Labor
  - *Time and expertise to analyze data.*

A sophisticated failure tracking system provides data to be used in a formal failure reporting, analysis and corrective action system, with the anticipated benefit of reduced defects.

— Failure Tracking —

Point of Application and Impact on Cycle Time	***Acquisition Timeline*** → Origin of Need | Design Specifications Development | Supplier Selection | Start Production | In-Process | End Production | Shipment/ Delivery | Final Use ■ Occurs during the delivery and final use periods of the acquisition timeline. ■ Does not impact the delivery cycle time of the product. ■ No impact on order placement lead time.
Benefits	**Prevent** ← **Identify** ■ Failure data allows the supplier to improve product quality by improving product design and/or changing processes. ■ Provides data to be used in a Failure Reporting, Analysis, and Corrective Action System (FRACAS).
Other	■ Data used to perform root cause analysis.